

CLAIMS

1. A drilling apparatus for drilling a deviated bore, said apparatus comprising:

5 a tubular outer member having an offset and for rotatably supporting a drill bit, the member having gripping means for selectively engaging the wall of a bore to restrain the member against rotation;

an inner member within the outer member and for
10 coupling to the drill bit at one end and to a drill string at another end;

wherein the apparatus has a first configuration in which the gripping means is retracted and the inner member is coupled to the outer member such that rotation
15 of the drill string provides for corresponding rotation of the inner and outer members, and a second configuration in which the gripping means is extended and the inner member is rotatable relative to the outer member such that the outer member is restrained from
20 rotation in the bore and rotation of the drill string provides for corresponding rotation of the inner member and the drill bit.

2. A drilling apparatus as claimed in claim 1, wherein
25 the inner member is at least one of axially moveable and rotatably moveable relative to the outer member, to reconfigure the apparatus.

3. A drilling apparatus as claimed in claim 1 or 2,
30 wherein the inner member includes an elongate drive member which extends through at least a portion of the outer member.

4. A drilling apparatus as claimed in claim 3, wherein the elongate drive member is a drive rod.

5. A drilling apparatus as claimed in claim 3 or 4,
5 wherein an upper portion of the inner member is adapted for coupling to the drill string, with a lower portion of the inner member adapted for coupling to the drill bit, the elongate drive member rotatably coupling the upper and lower portions.

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6. A drilling apparatus as claimed in claim 3, 4 or 5, wherein the drive member is flexible, to accommodate different relative orientations of the offset.

15 7. A drilling apparatus as claimed in any one of claims 3 to 6, wherein the drive member is axially moveable relative to at least one of the lower portion of the inner member and the drill bit.

20 8. A drilling apparatus as claimed in any one of claims 3 to 7, wherein the drive member and at least one of the lower portion of the inner member and the drill bit define a cooperating profile to provide rotational coupling while permitting relative axial movement.

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9. A drilling apparatus as claimed in claim 8, wherein the drive member has a hexagonal section, and the lower portion of the inner member or the drill bit defines a cooperating hexagonal bore.

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10. A drilling apparatus as claimed in any preceding claim, wherein the inner member is coupled to the outer member by engagement of at least one pin mounted on one

of the inner and outer members, with at least one complementary profiled track in the other of said inner and outer members.

5 11. A drilling apparatus as claimed in any preceding claim, wherein the inner member is coupled to the outer member by engagement of at least one pin on the outer surface of the inner member with at least one complementary profiled track on an inner surface of the
10 outer member.

12. A drilling apparatus as claimed in claim 11, wherein a plurality of pins are provided on the inner member which respectively engage complementary profiled tracks
15 in the outer member.

13. A drilling apparatus as claimed in any preceding claim, wherein the apparatus is arranged such that, in the first configuration, the relative rotational
20 orientation of the inner and outer members is predetermined.

14. A drilling apparatus as claimed in claim 10, 11, 12 or 13, wherein when pins on one member engage profiled
25 tracks on the other member, the pins and profiled tracks being arranged such that the pins will only engage with a selected respective profiled track.

15. A drilling apparatus as claimed in any one of claims
30 10 to 14, wherein one of the pins is longer than the others, and only a selected one of the profiled tracks has a lead-in which will accommodate the longer pin.

16. A drilling apparatus as claimed in any preceding claim, wherein the apparatus has a third configuration, in which third configuration, with weight applied to the apparatus, the gripping means is retracted and the inner
5 member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and the drill bit.

17. A drilling apparatus as claimed in claim 16, wherein
10 the apparatus in a third configuration may be utilised for rotary drilling with the offset rotating with the drill string and thus its directional effect negated.

18. A drilling apparatus as claimed in any preceding
15 claim, wherein the first configuration may be attained when the apparatus is lifted off bottom.

19. A drilling apparatus as claimed in any preceding claim, wherein the second configuration is attained with
20 weight applied to the apparatus.

20. A drilling apparatus as claimed in any preceding claim, wherein the apparatus is adapted to move between configurations sequentially, in response to the
25 application and lifting of weight to and from the apparatus.

21. A drilling apparatus as claimed in claim 20 when
30 dependent on claim 16 or 17, wherein the apparatus is cycled from the first configuration, to the second configuration, to the third configuration, and then to the first configuration.

22. A drilling apparatus as claimed in any preceding claim, wherein the gripping means are weight actuated such that the gripping means is extended and retracted in response to weight being applied to or lifted from the apparatus.

23. A drilling apparatus as claimed in any of the preceding claims, wherein the gripping means comprises axially extending members which buckle outwards on compression thereof.

24. A drilling apparatus as claimed in claim 23, wherein the members carry profiles adapted to grip the bore wall to prevent rotation but to permit axial sliding.

25. A drilling apparatus as claimed in claim 24, wherein the profiles are ridges.

26. A drilling apparatus as claimed in any preceding claim, wherein the gripping means is biased towards the retracted position.

27. A drilling apparatus as claimed in any preceding claim, wherein the apparatus includes a bearing between the inner and outer members such that, in the second configuration, weight may be applied to the drill bit from the drill string via the inner and outer members while the inner member and drill bit rotate relative to the outer member.

28. A drilling apparatus as claimed in any preceding claim, wherein the inner member is hollow.

29. A drilling apparatus as claimed in claim 28, in combination with a logging tool adapted to be run-in through the inner member.

5 30. A drilling apparatus for drilling a deviated bore, said apparatus comprising:

a tubular outer member having gripping means for selectively engaging the wall of a bore to restrain the member against rotation and including an offset portion
10 for rotatably supporting a drill bit;

an inner member located within the outer member and for coupling to the drill bit at one end and to a drill string at another end;

wherein the apparatus has a first configuration in
15 which the gripping means is retracted and the inner member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and a second configuration in which the gripping means is extended and
20 the inner member is rotatable relative to the outer member such that the outer member is restrained from rotation in the bore and rotation of the drill string provides for corresponding rotation of the inner member and the drill bit.

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31. A drilling apparatus as claimed in claim 30, wherein the inner member is moveable in at least one of axially and rotatably relative to the outer member to reconfigure the apparatus.

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32. A drilling apparatus as claimed in claim 30 or 31, wherein the offset portion is rotatably mounted within a

portion of the outer member and is rotatable relative thereto between a first position and a second position.

33. A drilling apparatus as claimed in claim 32, wherein
5 the offset portion is axially fixed relative to said portion of the outer member.

34. A drilling apparatus as claimed in any one of claims
31, 32 or 33, wherein rotation of the offset portion
10 between said first and second positions occurs in response to axial movement of the inner member with respect to said portion of the outer member.

35. A drilling apparatus as claimed in any one of claims
15 30 to 34, wherein the offset portion has an axis of rotation disposed at an angle from an axis of rotation of said portion of the outer member.

36. A drilling apparatus as claimed in any one of claims
20 32 to 35, wherein the drill bit is rotatably located relative to a lower end face of the offset portion, which lower end face is inclined from a lateral axis of the offset portion such that, in the first rotational position, the inclination of the end face is negated by
25 the angle of offset of the axis of rotation, resulting in the end face of the offset portion being positioned substantially parallel to an end face of said portion of the outer member.

30 37. A drilling apparatus as claimed in claim 36, wherein, in the second rotational position, the effect of the inclination of the end face in combination with the angle of offset of the rotational axis of the offset

portion results in the end face of the offset portion being inclined relative to the end face of said portion of the outer member.

5 38. A drilling apparatus as claimed in any one of claims 32 to 37, wherein, when the offset portion is in a first rotational position, the drill bit will be coaxially aligned with said portion of the outer member, and when the offset portion is in a second position, the drill bit
10 will be coaxially misaligned.

39. A drilling apparatus as claimed in any one of claims 32 to 38, wherein, in the first configuration of the apparatus, the drill bit is coaxially aligned with said
15 portion of the outer member, and in the second configuration, the drill bit is coaxially misaligned.

40. A drilling apparatus as claimed in any one of claims 32 to 39, wherein rotation of the offset portion relative
20 to said portion of the outer member is provided by at least one helical track located on the outer surface of the offset portion interacting with a respective rotationally fixed pin which is received within said at least one channel.

25 41. A drilling apparatus as claimed in claim 40, wherein a plurality of helical tracks are provided, and each interact with a respective pin.

30 42. A drilling apparatus as claimed in claim 40 or 41, wherein the at least one helical track is formed in the surface of the offset portion.

43. A drilling apparatus as claimed in claim 40 or 41, wherein the at least one helical track is defined by fixing elongate members to the outer surface of the offset portion.

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44. A drilling apparatus as claimed in any one of claims 40 to 43, wherein each rotationally fixed pin is provided on an inner surface of an intermediate tubular member which is located within the outer member, between
10 the inner member and offset portion.

45. A drilling apparatus as claimed in claim 44, wherein the intermediate member is axially moveable and rotationally fixed with respect to the outer member.

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46. A drilling apparatus as claimed in claim 45, wherein the intermediate member is axially moveable and rotationally fixed with respect to the outer member by a longitudinal sliding key and key-way arrangement.

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47. A drilling apparatus as claimed in claim 45 or 46, wherein the intermediate member is moved axially by corresponding axial movement of the inner member relative to the outer member, the arrangement being such that
25 movement of the inner member in a downwards direction will cause a bearing portion of the inner member to contact a corresponding bearing portion of the intermediate member, further downward movement of the inner member causing the intermediate member also to move
30 in a downwards direction.

48. A drilling apparatus as claimed in any one of claims 44 to 47, wherein at least one of the inner member and

intermediate member comprises a bearing race for location therebetween, in order to allow the inner member to rotate relative to the intermediate member.

5 49. A drilling apparatus as claimed in any one of claims 44 to 48, wherein the intermediate member is biased in an upwards direction.

10 50. A drilling apparatus as claimed in claim 47, 48 or 49, wherein, when the intermediate member is moved downwards, the offset portion is rotated to misalign the drill bit.

15 51. A drilling apparatus as claimed in any one of claims 47 to 50, wherein, when the intermediate member is moved in an upwards direction, the offset portion is rotated to coaxially align the drill bit with the outer member.

20 52. A drilling apparatus as claimed in any one of claims 30 to 51, wherein the inner member includes an elongate drive member which extends through at least a portion of the outer member.

25 53. A drilling apparatus as claimed in claim 52, wherein the elongate drive member is a drive rod.

30 54. A drilling apparatus as claimed in claim 52 or 53, wherein an upper portion of the inner member is adapted for coupling to the drill string, with a lower portion of the inner member adapted for coupling to the drill bit, the elongate drive member rotatably coupling the lower portion of the inner member and the drill bit.

55. A drilling apparatus as claimed in claim 52, 53 or 54, wherein the drive member is flexible, to accommodate different relative orientations of the offset.

5 56. A drilling apparatus as claimed in any one of claims 52 to 55, wherein the drive member is axially moveable relative to at least one of the lower portion of the inner member and drill bit.

10 57. A drilling apparatus as claimed in any one of claims 52 to 56, wherein the drive member and at least one of the inner member and drill bit define a cooperating profile to provide rotational coupling while permitting relative axial movement.

15 58. A drilling apparatus as claimed in claim 57, wherein the drive member has a hexagonal section, and the inner member or drill bit defines a cooperating hexagonal bore.

20 59. A drilling apparatus as claimed in any one of claims 30 to 58, wherein the inner member is coupled to the outer member by engagement of at least one pin mounted on one of the inner and outer members, with at least one complementary profiled path in the other of said inner
25 and outer members.

60. A drilling apparatus as claimed in any one of claims 30 to 59, wherein, wherein the inner member is coupled to the outer member by engagement of at least one pin on the
30 outer surface of the inner member with at least one complementary profiled path or track on an inner surface of the outer member.

61. A drilling apparatus as claimed in claim 60, wherein a plurality of pins are provided on the inner member which respectively engage complementary profiled paths in the outer member.

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62. A drilling apparatus as claimed in any one of claims 30 to 61, wherein the apparatus is arranged such that in a first configuration, the relative rotational orientation of the inner and outer members is predetermined.

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63. A drilling apparatus as claimed in any one of claims 59 to 62, wherein when pins on one member engage profiled tracks on the other member, the pins and profiled tracks being arranged such that the pins will only engage with a selected respective profiled track.

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64. A drilling apparatus as claimed in any one of claims 59 to 63, wherein one of the pins is longer than the others, and only a selected one of the profiled tracks has a lead-in which will accommodate the longer pin.

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65. A drilling apparatus as claimed in any one of claims 30 to 64, wherein the apparatus has a third configuration, in which third configuration, with weight applied to the apparatus, the gripping means is retracted and the drill bit is coaxially aligned with said portion of the outer member, and the inner member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and the drill bit.

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66. A drilling apparatus as claimed in claim 65, wherein the apparatus in a third configuration is utilised for fixed trajectory rotary drilling.

5 67. A drilling apparatus as claimed in any one of claims 30 to 66, wherein the first configuration may be attained when the apparatus is lifted off bottom.

68. A drilling apparatus as claimed in any one of claims
10 30 to 67, wherein the second configuration is attained with weight applied to the apparatus.

69. A drilling apparatus as claimed in any one of claims
30 to 68, wherein the apparatus is adapted to move
15 between configurations sequentially, in response to the application and lifting of weight to and from the apparatus.

70. A drilling apparatus as claimed in claim 69 when
20 dependent on claim 65 or 66, wherein the apparatus is cycled from the first configuration, to the second configuration, to the third configuration, and then to the first configuration.

25 71. A drilling apparatus as claimed in any one of claims 30 to 70, wherein the gripping means are weight actuated such that the gripping means is extended and retract in response to weight being applied to or lifted from the apparatus.

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72. A drilling apparatus as claimed in any one of claims 30 to 71, wherein the gripping means comprises axially

extending members which buckle outwards on compression thereof.

73. A drilling apparatus as claimed in claim 72; wherein
5 the members carry profiles adapted to grip the bore wall to prevent rotation but to permit axial sliding.

74. A drilling apparatus as claimed in any one of claims
30 to 73, wherein the gripping means is biased towards
10 the retracted position.

75. A directional drilling apparatus comprising first
and second cooperating drill bit support members for
mounting a drill bit to a drill string, the members being
15 arranged such that, in a first configuration, a lateral
axis of a drill bit supported by the members is
substantially parallel with a lateral axis of a drill
string on which the bit is mounted, and in a second
configuration the drill bit axis is offset from the drill
20 string axis.

76. A directional drilling apparatus as claimed in claim
75, wherein, in the second configuration, the drill bit
axis is offset at an angle from the drill string axis.

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77. A directional drilling apparatus as claimed in claim
75 or 76, wherein, in the first configuration, a
rotational axis of the drill bit is coaxially aligned
with a rotational axis of the drill string, and in the
30 second configuration, the rotational axis of the drill
bit is offset at an angle from the rotational axis of the
drill string.

78. A directional drilling apparatus as claimed in claim 75, 76 or 77, wherein the apparatus is moved from the first to second configurations in response to rotation of the second drill bit support member.

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79. A directional drilling apparatus as claimed in claim 78, wherein rotation of the second member is achieved in response to axial movement of the first member.

10 80. A drilling apparatus substantially as described herein and as shown in the accompanying representations.

81. A method of directional drilling utilising the apparatus as described in any preceding claim.

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